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(56) Documents Cited

GB 2141878 A

GB 0526121 A

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ONLINE: WPI

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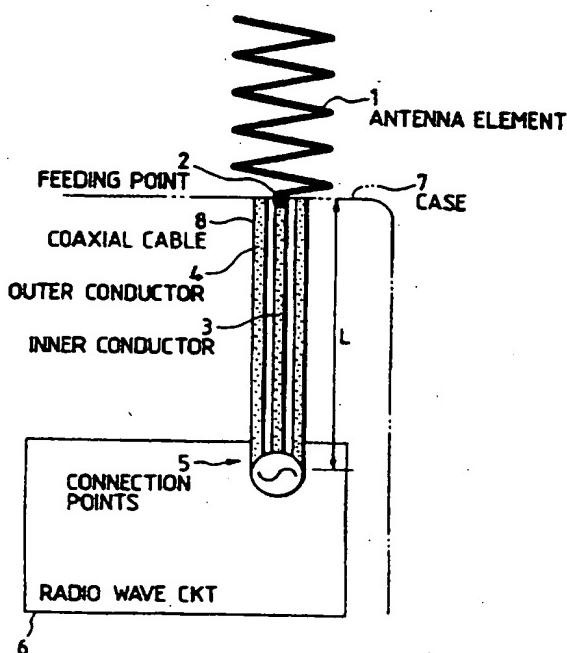
## (54) A resonant antenna

(57) The antenna comprises an antenna element 1 having a first electrical length and a feeding point 2. A coaxial cable 8 has a second electrical length and couples the feeding point 2 to a radio wave circuit 6. The first and second electrical lengths are determined so that the combination of antenna element and coaxial cable resonates at the frequency of interest. A resonant condition provides a standing wave along the antenna element and the outer conductor 4 (see fig. 2).

Preferably both the first and the second electrical lengths are substantially one quarter of the wavelength in use ( $\lambda/4$ ), and the coaxial cable may be flexible. The outer conductor 4 acts as an emission element, so that an unbalanced current can be prevented and so a balun is not necessary.

As the coaxial cable is flexible, the antenna element 1 and the radio wave circuit 6 can be brought together, so that the antenna apparatus can be miniaturized.

FIG. 1



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FIG. 1

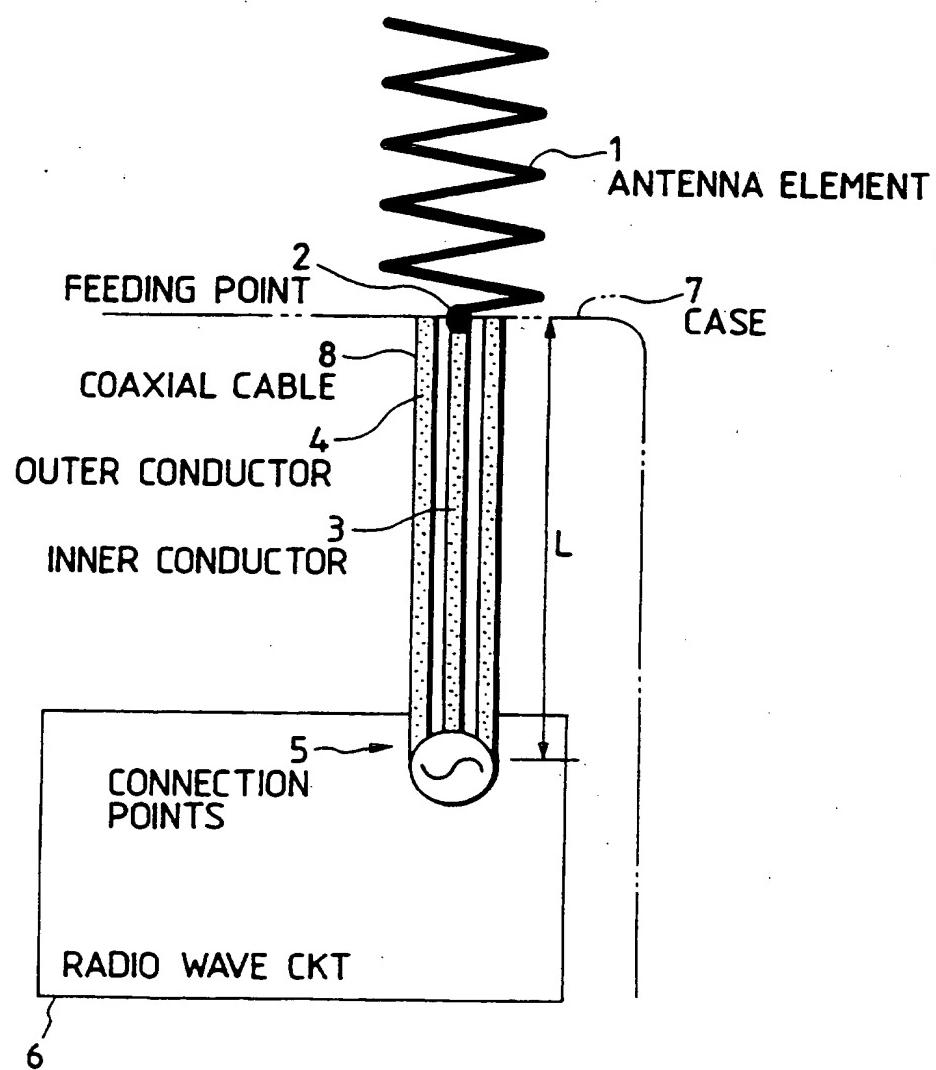
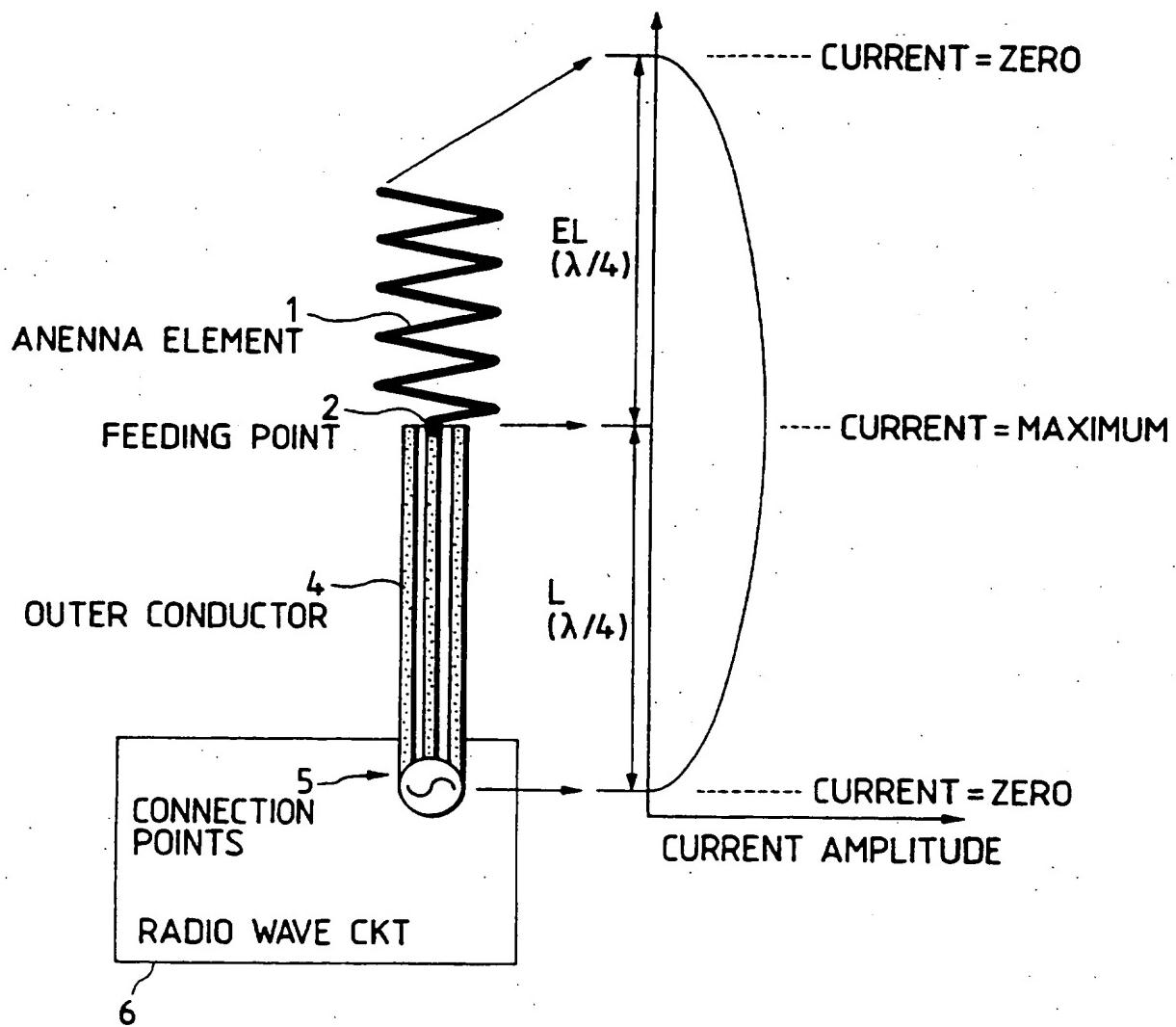


FIG. 2



antenna apparatus will be described.

A length of the antenna element 101 is a quarter of a wavelength used and acts as a monopole antenna. A length of the balun 107 is adjusted to a quarter of a wavelength

5 to provide a tuned condition at the used frequency. An impedance of the outer conductor 103 viewed from the connection point 106 becomes an infinite at an opposite end from the connection point 106, that is, that point shows an open condition, so that if a voltage is applied to that

10 point, no current flows through the outer conductor 103. As the result, this prevents an unbalanced current from flowing through an earth of the radio wave circuit from the antenna side and prevents a deterioration of a characteristic of the radio wave circuit 105.

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The aim of the present invention is to provide an improved antenna apparatus.

According to the present invention, an antenna apparatus is provided, which comprises: an antenna element

20 having a first electrical length and a feeding point at an end thereof; and a coaxial cable having an inner conductor and a coaxial outer conductor having a second electrical length, one end of the inner conductor being connected to the feeding point, another end of the inner conductor and a

25 corresponding end of the coaxial outer conductor being to

be coupled to a radio wave circuit, the first and second electrical lengths being determined to have a resonance to transmit a radio wave signal from the antenna element and the outer conductor on a transmission mode.

In the antenna apparatus, the first and second electrical lengths may be substantially a quarter of a wavelength used.

In the antenna apparatus, the coaxial cable may be flexible.

The features of the present invention will become more apparent from the following detailed description of an exemplary embodiment and the accompanying drawings, in which:-

Fig. 1 is a cross-sectional side view of an antenna apparatus of an embodiment of the present invention;

Fig. 2 is an illustration of this embodiment showing current amplitudes along the antenna element and the outer conductor of the antenna apparatus; and

Fig. 3 is a cross-sectional side view of a prior art sleeve antenna.

The same or corresponding elements or parts are designated with like references throughout the drawings.

Hereinbelow will be described an embodiment of this

invention.

Fig. 1 is a cross-sectional side view of an antenna apparatus of the embodiment of the present invention. In Fig. 1, numeral 1 denotes an antenna element having a helical form electrically connected to an inner conductor 3 of the coaxial cable 8 at a feeding point 2. An outer conductor 4 is provided around the inner conductor 3 of the coaxial cable. That is, the inner conductor 3, the outer conductor 4, an insulator between the inner conductor 3 and the outer conductor 4 form the coaxial cable 8. The inner conductor 3 and the outer conductor 4 are connected to a radio wave circuit 6 at the connection points 5 and transits an electric power from the radio wave circuit portion 6 to the feeding point 2. Numeral 7 denotes a case of the radio wave apparatus including this antenna apparatus and the radio wave circuit 6.

An operation of the antenna apparatus having the structure as mentioned above will be described.

Fig. 2 is an illustration of this embodiment showing current amplitudes along the antenna element 1 and the outer conductor 4. The antenna element 1 has an electrical length  $EL$  of a quarter of a wavelength  $\lambda$  of the used frequency and energized by a current flowing thereinto through the feeding point 2. A current flowing through the outer conductor 4 is induced by the current flowing through

the inner conductor 3 and is reflected at an end of the outer conductor 4 corresponding to the feeding point 2 and then, flows toward the connection point 5. Assuming that a length L of the coaxial cable 8 is a quarter of a 5 wavelength of the used frequency, since the current at the feeding point 2 is maximum, a current flowing through the outer conductor 4 of the coaxial cable 8 at the connecting point 5 is zero. Accordingly, a standing wave is generated along the antenna element 1 and the outer conductor 4 of 10 the coaxial cable 8. That is, a current distribution is provided which shows a maximum current amplitude at the feeding point 2 and a minimum amplitude, that is, zero, at the connection point 5 on the opposite side from the tip portion of the antenna element 1, so that a resonance 15 condition is provided. Thus, a dipole antenna is formed by the antenna element 1 and the outer conductor 4 of the coaxial cable, wherein the outer conductor 4 of the coaxial cable acts as an emission element. In this condition, the current in the outer conductor 4 of the coaxial cable 8 at 20 the connecting point 5 is zero, so that the outer conductor 4 is electrically disconnected from the radio wave circuit 6. Accordingly, an unnecessary current flows into an earth of the radio wave circuit 6 from the antenna side. As the result, the earth of the radio wave circuit 6 does not act 25 as an antenna, so that a characteristic of the radio wave

circuit 6 is not disturbed.

As mentioned, because, according to the embodiment mentioned above, the resonance condition is provided by generating the standing wave along the antenna element 1 and the outer conductor 4 of the coaxial cable 8 by setting the length L of the coaxial cable to the quarter of the wavelength of the used frequency. The outer conductor 4 of the coaxial cable 8 can act as the emission element, so that an unbalanced current can be prevented from flowing into the radio wave circuit 6. Moreover, because the coaxial cable has an elasticity, the antenna element 1 and the radio wave circuit portion 6 are made close each other, so that the antenna apparatus can be miniaturized.

In the above-mentioned embodiment, the length L of the coaxial cable 8 is assumed as the quarter of the wavelength. The length of the coaxial cable is affected by parts or the like arranged around the coaxial cable, so that the length may vary with the its circumference condition.

As mentioned the antenna apparatus of this embodiment comprises the antenna element 1 having the electrical length EL and the feeding point 2 at an end thereof; and the coaxial cable 8 having the inner conductor 3 and the coaxial outer conductor 4 respectively having an electrical length L, one end of the inner conductor 3 being

connected to the feeding point 2, another end of the inner conductor 3 and a corresponding end of the coaxial outer conductor being to be coupled to the radio wave circuit 6 at the connection points 5, the electrical lengths EL and L 5 being determined to have a resonance to transmit a radio wave signal from the antenna element 1 and the outer conductor 4 on a transmission mode.

The electrical lengths EL and L are substantially a quarter of a wave length used. Moreover, the coaxial cable 8 may be flexible.

C L A I M S

1. An antenna apparatus comprising:  
an antenna element having a first electrical length  
5 and a feeding point at an end thereof; and  
a coaxial cable having an inner conductor and a  
coaxial outer conductor respectively having a second  
electrical length, one end of said inner conductor being  
connected to said feeding point, another end of said inner  
10 conductor and a corresponding end of said coaxial outer  
conductor being to be coupled to a radio wave circuit, said  
first and second electrical lengths being determined to  
have a resonance to transmit a radio wave signal from said  
antenna element and said outer conductor on a transmission  
15 mode.
2. An antenna apparatus as claimed in claim 1, wherein  
said first and second electrical lengths are substantially  
a quarter of a wave length used.
3. An antenna apparatus as claimed in claim 1 or 2,  
wherein said coaxial cable is flexible.
4. A radio frequency apparatus comprising: a radio  
frequency circuit; and an antenna, said antenna comprising:  
an antenna element having a first electrical length and  
a feeding point at one end; and

a coaxial cable having a second electrical length and including an inner conductor and a coaxial outer conductor, a first end of said inner conductor being connected to said feeding point and a second end of said conductor being directly connected to said radio frequency circuit, wherein said first and second electrical lengths are determined so as that said antenna is substantially resonant at a radio frequency to be transmitted from said radio frequency circuit.

5. A radio frequency apparatus according to claim 4 having no balun associated with said antenna.

6. An antenna apparatus constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 1 and 2 of the accompanying drawings.



# The Patent Office



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**Your Reference:** MCM\21303  
**Application No:** GB 9913526.1

27 September 1999

Dear Sirs

### **Patents Act 1977: Search Report under Section 17(5)**

I enclose two copies of my search report and a copy of the citations.

#### **Scope of search**

Due to the broad nature of claims 1 and 18, especially in the light of the last paragraph of page 1 of your application, I have restricted my search to the subject matter of the narrower claim 1 where the antenna is formed as a **planar** spiral as in your specific embodiments.

MATSUSHITA and GEC MARCONI are cited below as examples of helical antennae which fall within claim 1. The additional five citations show planar spiral antennae according to your invention.

A further search may be necessary once you have made suitable amendments to your claims to more precisely define your invention. When making such amendments you should ensure that all your independent claims are linked by a single inventive concept.

#### **Publication**

I estimate that, provided you have met all formal requirements, preparations for publication of your application will be completed soon after **7 November 2000**. You will then receive a letter informing you of completion and telling you the publication number and date of publication.

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<sup>†</sup>Use of E-mail: Please note that under patent law e-mail may be used to file correspondence only.



Application No: GB 9913526.1  
Claims searched: 1-17

Examiner: Dr Andrew Glanfield  
Date of search: 7 October 1999

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H1Q (QDJ, QDX)

Int Cl (Ed.6): H01Q (1/36, 1/38, 9/27, 11/00, 11/12, 11/14, 11/16, 11/18)

Other: ONLINE: EPODOC, JAPIO, WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2312561 A (MATSUSHITA) see especially figure 1	1, 3, 9-11, 13, 18
X	GB 2256750 A (GEC MARCONI) see especially figure 1.	1-3, 9-11, 18
X	GB 1390514 (MARCONI) see especially figures 3 (a) and (b).	1, 3-6, 9- 11, 13, 15, 18
X	GB 781672 (STANDARD TELEPHONES) see especially figure 2.	1, 3, 9- 11, 13, 15, 18
X	EP 0825674 A1 (NIPPON) see especially figures 1a and 1b and line 3 to line 21 of column 3.	1, 3, 9-11, 13, 18
X	EP 0884796 A2 (MATSUSHITA) see especially figure 2 (b) and figures 3(a) and 3(b).	1②4-6, 9- 11, 13-④, 18
X	US 4511843 (THORAVAL) see figure 14.	1, 4, 5⑥, 9-11, 13, 15, 18

- X Document indicating lack of novelty or inventive step  
Y Document indicating lack of inventive step if combined with one or more other documents of same category.  
& Member of the same patent family

- A Document indicating technological background and/or state of the art.  
P Document published on or after the declared priority date but before the filing date of this invention.  
E Patent document published on or after, but with priority date earlier than, the filing date of this application.



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**Application No:** GB 9707420.7  
**Claims searched:** 1 to 5

**Examiner:** Peter Easterfield  
**Date of search:** 10 June 1997

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H1Q (QDJ, QDK, QDP, QDX, QHC, QHH, QHX, QJA)

Int Cl (Ed.6): H01Q 1/24, 1/27, 9/04, 9/06, 9/14, 9/38

Other: Online: WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2141878 A (NRDC) see fig. 4	1-5
A	GB 0526121 A (DE MONGE)	

- X Document indicating lack of novelty or inventive step  
Y Document indicating lack of inventive step if combined with one or more other documents of same category.  
& Member of the same patent family

- A Document indicating technological background and/or state of the art.  
P Document published on or after the declared priority date but before the filing date of this invention.  
E Patent document published on or after, but with priority date earlier than, the filing date of this application.



Application No: GB 9913526.1

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**Amendment/withdrawal**

If you wish to file amended claims for inclusion with the published application, or to withdraw the application to prevent publication, you must do so before the preparations for publication are completed. **No reminder will be issued.** If you write to the Office less than 3 weeks before the above completion date, please mark your letter prominently: "**URGENT - PUBLICATION IMMINENT**".

Yours faithfully

*A.R.Glanfield*

Dr Andrew Glanfield  
Examiner